

REMARKS

A. Status of the Claims / Amendments to the Claims

In the Office Action of February 18, 2009, the status of the claims was as follows:

- (1) Claims 74-90 were rejected under 35 U.S.C. §112 on various grounds.
- (2) Claims 74-82 and 84-90 were also rejected on various prior art grounds under 35 U.S.C. §103(a).

(3) Claim 83 was not rejected on any prior art grounds, and accordingly should be allowable if the Sec. 112 issues are addressed and Claim 74 is allowable, or if the claim is rewritten in independent form (as it has been in new Claim 103).

In this Amendment and Response/RCE, Claims 74, 77, 81, 88 and 90 have been amended to address the various Sec. 112 rejections, as explained further below. Claims 74 and 88 have also been amended to more clearly distinguish over the cited prior art. Claims 75 and 84 have been canceled, and new Claims 91-103 have been added.

No new matter has been added. The claim amendments and new claims are fully supported by the original disclosure, as explained further below.

In view of the claim amendments and the following Remarks/arguments for patentability, Applicants respectfully request that the various grounds of rejection in the last Office Action be reconsidered and withdrawn.

B. Amendments to the Specification – Paragraph 11

At paragraph 11 of the Office Action, the Examiner noted that the Specification does not contain a brief description of the drawings. The Specification has herein been amended

to add a “Brief Description of the Drawings” consistent with the drawings themselves and the way they are described or referenced in the original disclosure.

In identifying support for a claim amendment being made in this Response, it was noted that the paragraph at page 2, line 27 to page 3, line 2 contained an obvious typographical error. Specifically, at page 3, lines 1-2, the reference to “second electroluminescent metal complex or organo metallic complex” should have been to “first electroluminescent metal complex or organo metallic complex.”

That this was an obvious typographical error is readily seen by reading the three lines immediately following (page 3, lines 4-6) which state: “The band gap of the second organometallic complex can [thus] be larger than the band gap of the first electroluminescent metal complex or organo metallic complex....” One of ordinary skill in this art reading page 3, lines 4-6 of the Specification after reading the paragraph at page 2, line 27 to page 3, line 2 would immediately appreciate that the reference to “second” at page 3, line 1 was a typographical error that was meant to read “first” instead. Accordingly, Applicants respectfully request that this correction of an obvious typographical error be entered.

C. Claim Amendments / New Claims

The amendments to Claims 74 and 88 to recite “wherein the highest occupied molecular orbital ... metal complex” (and a comparable recitation in new independent Claims 91 and 103) are supported by the description in the Specification at page 2, line 27 to page 3, line 2, amended as discussed in part B above.

The amendments to Claims 74 and 88 (and a comparable recitation in new independent Claims 91 and 103) to recite in subparagraph (iii) that the various material layers

positioned “between the first and second electrodes” are “in sequence” are supported at various places in the original disclosure, for example, at page 2, lines 17-25; page 6, line 17 to page 7, line 22; and Figs. 17a and 17b and the description of these drawings at page 22, line 16 to page 25, line 8 (Examples 1-4).

The amendments to Claims 74 and 88 (and comparable recitations in new independent Claims 91 and 103) regarding layer thicknesses are supported by the original disclosure at page 3, lines 13-15, and also by Example 1 at pages 22-23 of the Specification.

New Claim 91 is substantially the same as previously pending Claim 75, but rewritten in independent form (and also incorporating the new amendments to Claim 74). New Claims 92-102 are substantially identical to Claims 76-83 and 85-87, respectively, but dependent on new Claim 91 instead of on Claim 74. As noted previously, new Claim 103 is Claim 83 rewritten in independent form. New Claim 103 should be considered to be allowable because Claim 83 was not subject to any prior art rejection.

D. Claim Interpretation Matters – Paragraph 10

In paragraph 10 of the Office Action, the Examiner noted several claim interpretation issues requiring clarification.

Relative to Claim 77 and the recitation of “TPD” the Examiner is correct in interpreting “TPD” as “referring to the diamine compound named prior to recitation of ‘(TPD)’ in claim 77.” With reference to the Examiner’s further comment concerning the chemical formula in Fig. 16b, Applicants agree to correct that formula in accordance with guidance from the Examiner. Applicants’ attorney will call the Examiner in a few days to

discuss this matter to insure that the correction of the chemical formula is made consistent with the Examiner's direction, and a Supplemental Amendment will then follow.

Applicants confirm that the Examiner's interpretation of the abbreviations "HTM-1", "TPTE", and "TADATA" are correct. Applicants agree to correct the "floating" CH₃ in Fig. 16c at the same time that the correction of Fig. 16b is submitted.

The typographical error of "α-NBP" appearing in Claim 77 has been corrected to "α-NPB" consistent with Fig. 16a.

Applicants further confirm that the Examiner's interpretations of the abbreviations "TMHD", "DBM", and "OPNP" are correct.

Applicants further confirm that the Examiner's interpretation of "Phen" in the chemical formula recited in Claim 83 as referring to phenanthrene, as described at page 5, lines 16-19 of the Specification is correct. Applicants also respectfully call the Examiner's attention to page 3, lines 27-32, of the Specification which identifies "gadolinium" as a preferred "second electroluminescent metal complex or organo metallic complex," and also to Example 1 (pages 22-23) which utilizes Gd(tmhd)₃ Phen as the second organometallic complex in an illustrative electroluminescent device according to the invention. It should further be noted that, in various places in the Specification where the ligands are being defined by reference to substituent groups R₁, R₂ and R₃, it is stated that "R₁, R₂ and R₃ can also form substituted and unsubstituted fused aromatic ... ring structures...." Accordingly, the recitation in Claim 83 is believed to be adequately supported by and within the scope of the Specification.

E. Sec. 112, First Para. Rejections – Paragraph 3

In paragraph 3 of the Office Action, Claims 74-90 were rejected under 35 U.S.C. §112, first paragraph, on the ground that the recitation “not containing a rare earth element” was “not clear.” In this Amendment and Response, this rejection has been obviated by deleting the phrase from Claims 74 and 88.

F. Sec. 112, Second Para. Rejections – Paragraph 4

In paragraph 4 of the Office Action, Claims 74-90 were rejected under 35 U.S.C. §112, second paragraph, as being “indefinite” in various respects.

Regarding Claims 74 and 88, these claims now recite that the several layers recited in subparagraph (iii) of these claims are “in sequence”. This amendment is believed to obviate this Sec. 112 rejection. Regarding Claim 75, Claim 75 has been canceled and replaced with new Claim 91, which also recites “in sequence”.

Regarding Claim 77, the typographical error relating to the chemical abbreviation has been corrected as suggested by the Examiner.

Regarding Claims 81 and 90, the word “predominantly” has been deleted, thereby obviating this Sec. 112 rejection.

G. Sec. 103 Rejection – Egusa ‘050 / Verhoeven ‘979

In paragraph 6 of the Office Action, Claims 74-76, 78, 79, 84, 85, 88 and 89 were rejected under 35 U.S.C. §103(a) as being unpatentable over Egusa ‘050 in view of Verhoeven ‘979. Applicants respectfully request reconsideration and withdrawal of this ground of rejection for the following reasons.

Independent Claims 74 and 88, and new independent Claims 91 and 103, recite that the layer (or layers) that are comprised of the second electroluminescent metal complex or second electroluminescent organometallic complex (layer (iii)(c) in Claim 74, for example) “has a thickness of about 10 nm”. In the rejection of paragraph 6 of the Office Action, the Examiner indicated that she was not convinced that a comparable claim recitation (in Claim 84) patentably distinguished over Egusa ‘050, and stated in this regard: “Absent a showing of criticality for a thickness of 10 nm for one layer of the multiple layers ... it is the examiner’s position that it would have been within the level of ordinary skill....” (emphasis added).

Applicants, however, respectfully call the Examiner’s attention to Example 1 at pages 22-23 of the Specification. Applicants respectfully submit that, as explained below, Example 1 clearly demonstrates the criticality of the “thickness of about 10 nm” claim recitation that now appears in Claims 74, 88, 91 and 103.

The claims now pending recite a composite electroluminescent layer comprising alternating sub-layers of different first and second electroluminescent metal complex or electroluminescent organometallic complex wherein the second complex has the following characteristics: (1) a band gap larger than that of the first complex; (2) the highest occupied molecular orbital (HOMO) for such second complex is higher, and the lowest occupied molecular orbital (LOMO) for such second complex is lower, than those of the first complex; and, (3) the layer(s) of the second complex have a thickness of about 10 nm or less. Claims 88 and 91 recite configurations where the composite electroluminescent layer includes at least two of the thin layers of second complex having the indicated characteristics.

As shown by the data of Example 1 of the subject application, using a layer of the second complex having a thickness of about 10 nm, with the specified band gap and the specified HOMO and LOMO properties, gives rise to a significant and unexpected increase in luminous efficiency (measured in Cd/A) compared to a similar device but with a layer of second complex having a thickness greater than 10 nm. Thus, in the first of the Example 1 experiments, the high band gap electroluminescent sub-layer (i.e., the layer of second complex) has a thickness substantially greater than 10 nm, namely 20.3 nm. The thickness of the overall set of electroluminescent sub-layers in this first of the Example 1 experiments is $23.6 + 20.3 + 24.2 = 68.1$ nm; and, the luminous efficiency of the resulting device is 1.13 cd/A.

In the second of the Example 1 experiments, there are two thin (10 nm) sub-layers of the second complex, each comprising a wide band gap (second complex) layer of 10 nm thickness. The thickness of the overall set of electroluminescent sub-layers for this Example 1 experiment is $23 + 10 + 10 + 10 + 23 = 76$ nm; and, the luminous efficiency of the resulting device is 2.01 Cd/A. This increase of 78% in luminous efficiency cannot be accounted for in terms of any significant change in the thickness of the overall composite electroluminescent layer, but instead has been found to arise from using wide band gap sub-layers of low (10 nm) thickness.

Similarly, in the third of the Example 1 experiments, there are two of the thin (10 nm) sub-layers having a wide band gap (i.e., the layers of the second complex), and HOMO level and LOMO level as specified. The thickness of the overall set of electroluminescent sub-layers for this Example 1 experiment is $23 + 10 + 10 + 10 + 23 = 76$ nm; and, the efficiency of the resulting device in Cd/A is 3.13. Here again, the thickness of the overall composite

electroluminescent layer is somewhat greater compared to the thickness of the overall composite electroluminescent layer in the first Example 1 experiment, but, compared to the first Example 1 experiment, the luminous efficiency of the device has unexpectedly increased by 177%.

These substantial increases in luminous efficiency associated with using second complex layers of about 10 nm in thickness are neither disclosed nor suggested by Egusa '050. This reference completely fails to disclose the thin (10 nm) high band gap (second complex) layer(s) now recited by the claims. As acknowledged by the Examiner, Egusa '050 also fails to disclose the use of the recited electroluminescent metal complexes and/or electroluminescent organometallic complexes as light emitting materials.

These deficiencies in Egusa '050 are not remedied by Verhoeven '979, which merely discloses electroluminescent devices based on lanthanide metal complexes. Even when these two disclosures are read together, Egusa '050 and Verhoeven '979 fail to disclose an electroluminescent device as claimed, and they certainly do not suggest the significantly improved luminous efficiency of a device as presently claimed. The Examiner has noted the need to show the criticality of the thickness(es) of the second complex layer(s), and comparison of the first with the second and third experiments in Example 1, as discussed above, makes it clear that a 10 nm thickness of the high band gap (second complex) layer gives rise to a dramatic and completely unexpected increase in the luminous efficiency of the resulting device.

For all of these reasons, the rejection of claims based on the combination of Egusa '050 and Verhoeven '979 should be reconsidered and withdrawn.

H. Sec. 103 Rejection – Egusa ‘050 / Verhoeven ‘979 / Mori ‘489

In paragraph 7 of the Office Action, Claims 77, 86 and 87 were rejected under 35 U.S.C. §103(a) as being unpatentable over Egusa ‘050 in view of Verhoeven ‘979 and further in view of Mori ‘489. Applicants respectfully request reconsideration and withdrawal of this ground of rejection for the following reasons.

The deficiencies in the reference combination of Egusa ‘050 and Verhoeven ‘979 relative to the currently pending set of claims have been thoroughly discussed in part G above. It appears that Mori ‘489 was cited here only to show specific features as recited in Claim 77 (TPD as the hole transport material) and in Claims 86 and 87 (a metal quinolate as the electron transport material) that the Examiner acknowledged are not shown by Egusa ‘050 or Verhoeven ‘979.

But, Mori ‘489 fails to correct the fundamental deficiencies of Egusa ‘050 and Verhoeven ‘979 as references relative to the pending claims. Thus, Mori ‘489 does not teach anything about using a sequenced set of electroluminescent layers of metal complexes or organometallic complexes in fabricating an electroluminescent device. Mori ‘489 does not teach anything about using two different electroluminescent materials in an electroluminescent layer sequence, wherein one of those electroluminescent materials has a band gap larger than the other electroluminescent material. Mori ‘489 also does not teach anything about using two different electroluminescent materials in an electroluminescent layer sequence, wherein one of those electroluminescent materials has a HOMO that is higher, and a LOMO that is lower, than the other electroluminescent material. Furthermore, Mori ‘489 does not teach anything about using two different electroluminescent layers in an electroluminescent layer sequence, wherein the electroluminescent material having the larger

band gap is only used in layers of about 10 nm or less in thickness. As discussed in part G above, Example 1 of this application demonstrates the “criticality” of the layer thickness recitation in the pending claims.

For all of these reasons, the rejection of claims based on the combination of Egusa ‘050, Verhoeven ‘979 and Mori ‘489 should be reconsidered and withdrawn.

I. Sec. 103 Rejection – Egusa ‘050 / Kathirgamanathan ‘037

In paragraph 8 of the Office Action, Claims 74-82 and 84-90 were rejected under 35 U.S.C. §103(a) as being unpatentable over Egusa ‘050 in view of Kathirgamanathan ‘037. Applicants respectfully request reconsideration and withdrawal of this ground of rejection for the following reasons.

The deficiencies of Egusa ‘050 as a reference relative to the currently pending set of claims have been thoroughly discussed in part G above. Also, the Examiner acknowledged in this rejection that: “Egusa et al. do not disclose the use of electroluminescent metal complexes and/or organometallic complexes as the light emitting materials.” Kathirgamanathan ‘037 was cited to show electroluminescent metal complexes as light emitting materials.

But, Kathirgamanathan ‘037 fails to correct any of the other fundamental deficiencies of Egusa ‘050 as a reference relative to the pending claims. Thus, Kathirgamanathan ‘037 does not teach anything about using a sequenced set of electroluminescent layers of metal complexes or organometallic complexes in fabricating an electroluminescent device. Kathirgamanathan ‘037 does not teach anything about using two different electroluminescent materials in an electroluminescent layer sequence, wherein one of those electroluminescent

materials has a band gap larger than the other electroluminescent material.

Kathirgamanathan '037 also does not teach anything about using two different electroluminescent materials in an electroluminescent layer sequence, wherein one of those electroluminescent materials has a HOMO that is higher, and a LOMO that is lower, than the other electroluminescent material. Furthermore, Kathirgamanathan '037 does not teach anything about using two different electroluminescent layers in an electroluminescent layer sequence, wherein the electroluminescent material having the larger band gap is only used in layers of about 10 nm or less in thickness. As discussed in part G above, Example 1 of this application demonstrates the "criticality" of the layer thickness recitation in the pending claims.

For all of these reasons, the rejection of claims based on the combination of Egusa '050 and Kathirgamanathan '037 should be reconsidered and withdrawn.

J. Sec. 103 Rejection – Sato '818 / Forrest '360

In paragraph 9 of the Office Action, Claims 74-78 and 85-88 were rejected under 35 U.S.C. §103(a) as being unpatentable over Sato '818 in view of Forrest '360. Applicants respectfully request reconsideration and withdrawal of this ground of rejection for the following reasons.

The Sato '818 reference appears to merely disclose an electroluminescent device in which the electroluminescent layer comprises two hosts, one of which acts as a sensitizer for the other. The Examiner acknowledged that Sato '818 does not disclose the use of alternating electroluminescent layers.

The Examiner's citation of Forrest '360 does not overcome the deficiencies of the Sato '818 reference. Forrest '360 discloses an electroluminescent device in which there is a stack of electroluminescent layers having a particular set of properties (as specified, for example, in Claim 1 of this reference). Thus, in Example 1 of Forrest '360 (at col. 13), the composite electroluminescent layer is comprised of a series of ten alternating sub-layers, each 1 nm (10 Å) thick. Each of these sub-layers has a common host (which is CBP), and alternate layers are doped respectively with either a phosphorescent sensitizer or with a fluorescent emitter. There is also a blocking layer of bathocuproine 20 nm (200 Å) thick and a layer of electron transport material. The phosphorescent sensitizer used in this reference is taught to be more efficient than its fluorescent analog, with host triplets being transferred to the fluorescent singlet state.

Thus, for Forrest '360 to even approximate the claimed invention, the composite luminescent layer of Forrest '360: (1) would have to comprise sub-layers of different thicknesses (which is not taught by the reference); (2) the thinner sub-layer(s) would have to comprise bathocuproine; and, (3) the bathocuproine sub-layer(s) would have to have a thickness of 10 nm or less (rather than 20 nm as in the bathocuproine blocking layer taught by Forrest '360). Based on comparing the results of experiment 1 of Example 1 of the present application with the results of experiments 2 and 3 of Example 1, it is clear that reducing the thickness of the high band gap sub-layer from 20 nm to 10 nm, without any significant change in the overall thickness of the composite electroluminescent layer, gives rise to a substantial and entirely surprising increase in luminescent efficiency. Nothing in Forrest '360 discloses or suggests either the specific electroluminescent sub-layer

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arrangement recited in the claims or the unexpected benefits resulting from that specific layer arrangement in combination with the recited layer thicknesses.

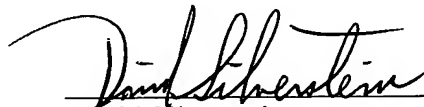
For all of these reasons, the rejection of claims based on the combination of Sato '818 and Forrest '360 should be reconsidered and withdrawn.

SUMMARY AND CONCLUSIONS

For all of the foregoing reasons, Claims 74, 76-83 and 85-103 now pending are believed to be in condition for allowance and an early notice thereof is earnestly requested.

Respectfully submitted,

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